TRIBOLOGY IN THE SOFT WORLD: COMPLIANT BOUNDARIES AND COMPLEX ENVIRONMENT

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ABSTRACT
The great majority of surface forces studies reported up to date have investigated relatively rigid objects. However, many systems of interest require a knowledge of the interaction between compliant materials. For instance, most systems of interest in biotribology involve soft boundaries. In a typical contact of rigid bodies, only deformations close to the interaction zone must be considered. On the contrary, the shape of compliant bodies can change at much larger distances, and the long-range effect of surface forces must be considered.

In this work, we investigated a number of compliant systems under shear, including supported gels and thin membranes. By studying microgel films, we found that long-range, distance-dependent repulsive interactions might have a critical effect on the contact mechanics of the system, limiting the minimum approach of the surfaces under pressure. The pressure-induced contact stiffening reduces the effect of normal load on friction, by limiting the minimum approach while increasing the effective contact radius. This effect should be significant for tribopairs with a long-range repulsive interaction —as often observed with macromolecular coatings— when the effective distance-range of normal and frictional forces are significantly different. In addition, we have observed that significant normal forces emerges between compliant surfaces in relative motion, with important consequences in lubrication, in particular under small applied normal loads. This emerging shear-induced repulsive pressure is associated with the elastohydrodynamic coupling, and the symmetry breaking of the contact geometry under shear.

Finally, we describe a soft-membrane-based surface forces apparatus, developed to study the interaction between a thin compliant circular membrane attached to a rigid cylinder, and a moving sphere. By studying the shape of the membrane, we have explored the pressure field developed upon changes in velocity and sphere-membrane separation.

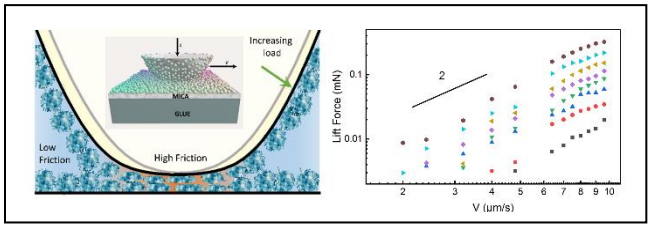

Fig.1 Schematic representation of the microgel-coated surfaces under load, and shear-induced lift force vs. driving speed at different imposed surface separations

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